

03500.015390

PATENT APPLICATION



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

TAKEHIKO NAKAI

Application No: 09/866,587

Filed: May 30, 2001

For: DIFFRACTIVE OPTICAL
ELEMENT AND OPTICAL SYSTEM :
HAVING THE SAME)

Examiner: A. Amari

Group Art Unit: 2872

September 26, 2002

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Technology Center 2100

Commissioner for Patents
Washington, D.C. 20231

AMENDMENT AND SECOND SUPPLEMENTAL
INFORMATION DISCLOSURE STATEMENT

09/30/2002 WABDELRI 00000022 09866587

01 FC:126

180.00 OP

Sir:

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In response to the Office Action dated June 26, 2002, the Examiner is

respectfully requested to amend the above-identified application as follows:

09/27/2002 HREKONEN 00000049 09366587

01 FC:126

180.00 OP

IN THE SPECIFICATION:

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Please substitute the following paragraph for the paragraph starting on page 2,

line 10 and ending at line 19. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--As to this SWS grating, it is known that such SWS gratings may own various functions such as a double refraction (birefringence) wavelength plate, an antireflection structure,

09/27/2002 HREKONEN 00000049 09366587
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09/30/2002

and a polarization beam splitter, depending upon grating structures thereof. Then, as to these functions, various reports have been made in which there is a small optical performance variation caused by changes in incident angles of light beams entered into this SWS grating, and the SWS grating may have optically superior features.--

Please substitute the following paragraph for the paragraph starting at page 12, line 3 and ending at line 5. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--Fig. 1 is a perspective view for representing a diffractive optical element according to an embodiment 1 of the present invention;--

Please substitute the following paragraph for the paragraph starting at page 13, line 20 and ending at line 23. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--Fig. 1 is a perspective view for indicating a diffractive optical element which performs a polarization separation operation, according to an embodiment 1 of the present invention.--

Please substitute the following paragraph for the paragraph starting at page 13, line 24 and ending at page 14, line 1. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--In the diffractive optical element 1 for performing the polarization separation operation, a diffraction grating 3 capable of performing the polarization separation operation is provided on a substrate 2.--

Please substitute the following paragraph for the paragraph starting at page 14, line 2 and ending at line 11. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--The diffraction grating 3 is constituted by a one-dimensional blazed type grating shape, and has a grating period " P_t " along a direction of 2 - 2 shown in this drawing. In the diffractive optical element 1, diffraction directions of light beams incident on diffractive optical element 1 are made different from each other, depending upon polarization directions thereof. Further, this diffraction grating 3 is set in such a manner that each of polarized lights is diffracted only at a specific diffraction order.--

Please substitute the following paragraph for the paragraph starting at page 15, line 19 and ending at line 27. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--One the other hand, the second diffraction grating portion 5 has an SWS grating structure in which the material $n_1(\lambda)$ and the material $n_2(\lambda)$ are alternatively repeated with a minute period smaller than the wavelength of the light used. The grating pitch of the SWS grating is " P_1 ", and an occupation ratio of the material $n_2(\lambda)$ which is occupied within the grating pitch " P_1 " is equal to $F = f_1 / P_1$ (will be referred to as a "filling factor" hereinafter).--

Please substitute the following paragraph for the paragraph starting at page 15, line 1 and ending at line 4. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--The shape of this second diffraction grating portion 5 is such a one-dimensional rectangular grating shape having a period parallel to the grating pitch "Pt" of the first diffraction grating portion 4.--

IN THE ABSTRACT:

Please substitute the following Abstract for the Abstract starting at page 34, line 2 and ending at line 14. A marked-up copy of this paragraph, showing the changes made thereto is attached.

--In a diffractive optical element and a polarization separation element using this diffractive optical element, incident light can be effectively separated for the respective polarization directions over the entire used wavelength range. The diffractive optical element is arranged such that the diffractive optical element has a grating structure in which at least two blazed type grating portions are successively arranged along a light traveling direction. Additionally, in at least one grating portion of the two blazed type grating portions, structures smaller than a used wavelength are arranged in a periodic manner.--

IN THE CLAIMS:

Please amend Claims 1, 5-8 and 10-13 as follows. A marked-up copy of the amended claim showing the changes made thereto, is attached. Note that all the claims currently

pending in this application, including those not presently being amended, have been reproduced below for the Examiner's convenience.

1. (Amended) A diffractive optical element, comprising:
a grating structure having at least two blazed type grating portions successively arranged along a light traveling direction, wherein
in at least one grating portion of said two blazed type grating portions, structures smaller than a used wavelength are arranged in a periodic manner.
2. (Not Amended) A diffractive optical element according to claim 1, wherein said diffractive optical element is structured such that within an entire region of used wavelengths, diffraction directions are made different from each other, depending upon a polarization direction of a light beam incident on said diffractive optical element, and a diffracted light is concentrated only to one predetermined diffraction order.
3. (Not Amended) A diffractive optical element according to claim 1, wherein said minute periodic structure is constituted by one kind of material, or two kinds of materials, and occupation ratios of the respective materials within one period of said minute periodic structure are made different from each other along a periodic direction of said grating portion.
4. (Not Amended) A diffractive optical element according to claim 1, wherein said diffractive optical element has a step-shaped grating portion.

5. (Amended) A diffractive optical element according to claim 4, wherein said minute periodic structure of said grating portion is varied along a periodic direction of said grating portion.

6. (Amended) A diffractive optical element according to claim 5, wherein said minute periodic structure varied along the periodic direction of said grating portion is varied every step of said step-shaped grating portions.

7. (Amended) A diffractive optical element according to claim 4, wherein said minute periodic structure of said grating portion is varied in a grating thickness direction.

8. (Amended) A diffractive optical element according to claim 7, wherein said minute periodic structure varied in the grating thickness direction is varied every step of said step-shaped grating portion.

9. (Not Amended) A diffractive optical element according to claim 1, wherein said used wavelength range corresponds to a visible light range.

10. (Amended) A polarization converting element, comprising deflecting means provided so that an emergence direction of one of a P-polarized light beam and an S-polarized light beam which has undergone polarization-separation to be diffracted in a diffraction direction different depending on a polarization direction by said diffractive optical element

according to claim 2 is made substantially coincident with an emergence direction of the other beam.

11. (Amended) A polarization converting element, comprising a half-wave plate provided in correspondence to one of a P-polarized light beam and an S-polarized light beam, which has undergone polarization-separation to be diffracted in a direction different depending upon polarization direction, by said diffractive optical element according to claim 2.

12. (Amended) A polarization converting element, comprising deflecting means provided so that an emergence direction of one of a P-polarized light beam and an S-polarized light beam which has undergone polarization-separation to be diffracted in a diffraction direction different depending on a polarization direction by said diffractive optical element according to claim 2 is made substantially coincident with an emergence direction of the other beam and a half-wave plate is provided in correspondence to one of the P-polarized light beam and S-polarized light beam.

13. (Amended) A polarization converting element according to any one of claims 10 to 12, further comprising an optical member provided so that an incident direction of a light beam on said diffractive optical element is made substantially parallel to an emergence direction thereof.

14. (Not Amended) A projection type display apparatus, in which a light beam which is emitted from a light source unit and contains an S-polarized light component and

a P-polarized light component, is guided using the polarization converting element according to any one of claims 10 to 12 toward modulating means for modulating the light beam on the basis of an image signal and the light beam modulated by said modulating means is projected onto a predetermined surface by a projection optical system.

15. (Not Amended) A projection type display apparatus according to claim 14, wherein said image signal is controlled in response to a signal supplied from an image processing means.

REMARKS

Claims 1-15 are presented for consideration, with Claim 1 being independent.

The specification and abstract have been reviewed and amended to correct minor informalities and improve their idiomatic English form.

Independent Claim 1 has been amended to further distinguish Applicant's invention from the cited art. In addition, editorial changes have been made to selected dependent claims.

Claims 1-9 stand rejected under 35 U.S.C. §102(b) as allegedly being anticipated by Aoyama '903. In addition, Claims 10-15 were rejected under 35 U.S.C. §103 as allegedly being obvious over Aoyama in view of European Patent No. 821,258. These rejections are respectfully traversed.

Applicant's invention as set forth in Claim 1 relates to a diffractive optical element comprising a grating structure having at least two blazed type grating portions

successively arranged along a light traveling direction. In at least one grating portion, structures smaller than a used wavelength are arranged in a periodic manner.

In accordance with Applicant's claimed invention, an effective and economical diffractive optical element can be provided.

The primary citation to Aoyama relates to an optical element that includes a grating structure. In the embodiment shown in Figures 6 and 7, a Fresnel lens pattern 21 and a grating 22 are provided on a transparent substrate. In Figures 9-11, a composite grating pattern on a substrate 30 is formed of a high density linear grating 32 superimposed on a Fresnel lens pattern 31.

In contrast to Applicant's claimed invention, however, Aoyama is not understood to teach or suggest, among other features, two blazed type grating portions successively arranged along a light traveling direction. Accordingly, it is respectfully submitted that Aoyama fails to anticipate or render obvious Applicant's claimed invention. Reconsideration and withdrawal of the rejection of Claims 1-9 under 35 U.S.C. §102 is therefore respectfully requested.

The secondary citation to EP '258 relates to an optical element and was cited for its teaching of a polarization converting element. This reference fails, however, to compensate for the deficiencies in Aoyama as discussed above with respect to Applicant's independent Claim 1.

Therefore, without conceding the propriety of combining Aoyama and EP '258 in the manner proposed in the Office Action, such a combination still fails to teach or suggest

Applicant's claimed invention. Accordingly, reconsideration and withdrawal of the rejection of Claims 10-15 under 35 U.S.C. §103 is respectfully requested.

Accordingly, it is submitted that Applicant's invention as set forth in independent Claim 1 is patentable over the cited art. In addition, dependent Claims 2-15 set forth additional features of Applicant's invention. Independent consideration of the dependent claims is respectfully requested.

SECOND SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT

In compliance with the duty of disclosure under 37 C.F.R. §1.56 and in accordance with the practice under 37 C.F.R. §§1.97 and 1.98, the Examiner's attention is directed to the documents listed on the enclosed Form PTO-1449. Copies of the listed documents are also enclosed.

Accompanying this paper is a check for \$180.00 pursuant to 37 C.F.R. §1.97(c) and §1.17(p).

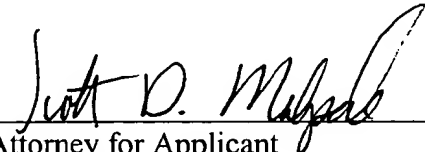
It is respectfully requested that the above information be considered by the Examiner and that a copy of the enclosed Form PTO-1449 be returned indicating that such information has been considered.

CONCLUSION

In view of the foregoing, reconsideration and allowance of this application is deemed to be in order and such action is respectfully requested.

Applicant's undersigned attorney may be reached in our Washington, D.C.
office by telephone at (202) 530-1010. All correspondence should continue to be directed to our
below-listed address.

Respectfully submitted,



Attorney for Applicant
Scott D. Malpede
Registration No. 32,533

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SDM/vmm

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VERSION WITH MARKINGS TO SHOW CHANGES MADE TO SPECIFICATION

The paragraph starting at page 2, line 10 and ending at line 19 has been amended as follows:

As to this SWS grating, it is known that such SWS gratings may own various functions such as a double refraction (birefringence) wavelength plate, an antireflection structure, and a polarization beam splitter, depending upon grating structures thereof. Then, as to these functions, various reports have been made in which there is a small optical performance variation caused by changes in incident angles of light [beames] beams entered into this SWS grating, and the SWS grating may have optically superior features.

The paragraph starting at page 12, line 3 and ending at line 5 has been amended as follows:

--Fig. 1 is a perspective view for representing a diffractive optical element according to an embodiment 1 of the present invention;

The paragraph starting at page 13, line 20 and ending at line 23 has been amended as follows:

Fig. 1 is a perspective view for indicating a diffractive optical element which performs a [polization] polarization separation operation, according to an embodiment 1 of the present invention.

The paragraph starting at page 13, line 24 and ending at page 14, line 1 has been amended as follows:

In the diffractive optical element 1 for performing the [polarization] polarization separation operation, a diffraction grating 3 capable of performing the [polarization] polarization separation operation is provided on a substrate 2.

The paragraph starting at page 14, line 2 and ending at line 11 has been amended as follows:

The diffraction grating 3 is constituted by [an] a one-dimensional blazed type grating shape, and has a grating period "Pt" along a direction of 2 - 2 shown in this drawing. In the diffractive optical element 1, diffraction directions of light [beames] beams incident on diffractive optical element 1 are made different from each other, depending upon polarization directions thereof. Further, this diffraction grating 3 is set in such a manner that each of polarized lights is diffracted only at a specific diffraction order.

The paragraph starting at page 15, line 19 and ending at line 27 has been amended as follows:

One the other hand, the second diffraction grating portion 5 has an SWS grating structure in which the material $n_1(\lambda)$ and the material $n_2(\lambda)$ are alternatively repeated with a minute period smaller than the wavelength of the light used. The grating pitch of the SWS

grating is "P1", and an occupation ratio of the material $n_2(\lambda)$ which is occupied within the grating pitch "P1" is equal to $F = f_1 / P_1$ (will be referred to as a "filling factor" hereinafter).

The paragraph starting at page 15, line 1 and ending at line 4 has been amended as follows:

The shape of this second diffraction grating portion 5 is such [an] a one-dimensional rectangular grating shape having a period parallel to the grating pitch "Pt" of the first diffraction grating portion 4.

VERSION WITH MARKINGS TO SHOW CHANGES MADE TO THE ABSTRACT

The Abstract of the Disclosure section starting at page 34, line 2 and ending at line 14 has been amended as follows:

In a diffractive optical element and a polarization separation element using this diffractive optical element, incident light can be effectively separated for the respective polarization directions over the entire used wavelength range. The diffractive optical element is arranged such that the diffractive optical element has a grating structure in which at least two blazed type grating [potions] portions are [overlapped with each other, and] successively arranged along a light traveling direction. Additionally, in at least one grating portion of the two blazed type grating portions, structures smaller than a used wavelength are arranged in a periodic manner [on all of light incident surfaces thereof].

VERSION WITH MARKINGS TO SHOW CHANGES MADE TO CLAIMS

1. (Amended) A diffractive optical element, [wherein said diffractive optical element has] comprising:

a grating structure [in which] having at least two blazed type grating portions [are overlapped with each other] successively arranged along a light traveling direction,

[and] wherein

in at least one grating portion of said two blazed type grating portions, structures smaller than a used wavelength are arranged in a periodic manner [on all of light incident surfaces thereof].
5. (Amended) A diffractive optical element according to claim 4, wherein [the] said minute periodic structure of [the] said grating portion is varied along [the] a periodic direction of [the] said grating portion.
6. (Amended) A diffractive optical element according to claim 5, wherein said minute periodic structure varied along the periodic direction of said grating portion is varied every step of [the] said step-shaped grating [stepped] portions.
7. (Amended) A diffractive optical element according to claim 4, wherein [the] said minute periodic structure of [the] said grating portion is varied in a grating thickness direction.

8. (Amended) A diffractive optical element according to claim 7, wherein [the] said minute periodic structure varied in the grating thickness direction is varied every step of [the] said step-shaped grating [stepped] portion.

10. (Amended) A polarization converting element, [wherein] comprising deflecting means [is] provided so that an emergence direction of one of a P-polarized light beam and an S-polarized light beam which has undergone polarization-separation to be diffracted in a diffraction direction different depending on a polarization direction by said diffractive optical element according to claim 2 is made substantially coincident with an emergence direction of the other beam.

11. (Amended) A polarization converting element, [wherein] comprising a half-wave plate [is] provided in correspondence to one of a P-polarized light beam and an S-polarized light beam, which has undergone polarization-separation to be diffracted in a direction different depending upon polarization direction, by [the] said diffractive optical element according to claim 2.

12. (Amended) A polarization converting element, [wherein] comprising deflecting means [is] provided so that an emergence direction of one of a P-polarized light beam and an S-polarized light beam which has undergone polarization-separation to be diffracted in a diffraction direction different depending on a polarization direction by said diffractive optical

element according to claim 2 is made substantially coincident with an emergence direction of the other beam and a half-wave plate is provided in correspondence to one of the P-polarized light beam and S-polarized light beam.

13. (Amended) A polarization converting element according to any one of claims 10 to 12, [wherein] further comprising an optical member [is] provided so that an incident direction of a light beam on said diffractive optical element is made substantially parallel to an emergence direction thereof.

In re Application of:

TAKEHIKO NAKAI

Application No. 09/966,587

Filed: May 30, 2001

For: DIFFRACTIVE OPTICAL ELEMENT
AND OPTICAL SYSTEM HAVING THE
SAME

COMMISSIONER FOR PATENTS
Washington, D.C. 20231

Sir:

Transmitted herewith is an Amendment in the above-identified application.

☒ No additional fee is required.

The fee has been calculated as shown below:

CLAIMS AS AMENDED						
	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NO. PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE	ADDITIONAL FEE
TOTAL CLAIMS	21	MINUS	21	= 0	x \$9 \$18	
INDEP. CLAIMS	1	MINUS	3	= 0	x \$42 \$84	
Fee for Multiple Dependent claims \$140°/\$280						
TOTAL ADDITIONAL FEE FOR THIS AMENDMENT---						\$ -0-

☐ °Verified Statement claiming small entity status is enclosed, if not filed previously.

☐ A check in the amount of \$_____ is enclosed.

Docket No.: 03500.015300

Examiner: A. Amari

Group Art Unit: 2872

Date: September 26, 2001



This S/N is incorrect -
The correct number is 09/866,587 see

09/866,587 SE
corrected S/N

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☐ Charge \$____ to Deposit Account No. 06-1205. A duplicate copy of this sheet is enclosed.

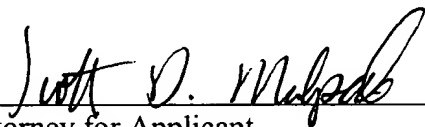
☒ Any prior general authorization to charge an issue fee under 37 C.F.R. 1.18 to Deposit Account No. 06-1205 is hereby revoked. The Commissioner is hereby authorized to charge any additional fees under 37 C.F.R. 1.16 and 1.17 which may be required during the entire pendency of this application, or to credit any overpayment, to Deposit Account No. 06-1205. A duplicate copy of this paper is enclosed.

☐ A check in the amount of \$_____ to cover the fee for a _____ month extension is enclosed.

☒ A check in the amount of \$ 180.00 to cover the Information Disclosure Statement fee is enclosed.

☒ Applicant's undersigned attorney may be reached in our Washington, D.C. office by telephone at (202) 530-1010. All correspondence should continue to be directed to our address given below.

Respectfully submitted,



Attorney for Applicant
Scott D. Malpede
Registration No. 32,533

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